U.S. Department of Energy
Energy Efficiency and Renewable Energy

industrial technologies program

Tools and Training for Industrial Energy Efficiency

Office of Industrial Technologies
Energy Efficiency and Renewable Energy
U.S. Department of Energy

Texas Technology Showcase
March 2003

Tools Available on Our Web Site

- **Motor Master +** – Assists in energy-efficient motor selection and management.
- **Pumping System Assessment Tool** – Helps industrial users assess the efficiency of pumping system operations.
- **Steam System Scoping Tool** – Profiles and grades steam system operations and management.
- **Steam System Assessment Tool** – Assists users in assessing potential benefits of specific steam-system improvements
- **Air Master+** – Provides comprehensive information on assessing compressed air systems.
- **3EPlus Insulation Assessment Tool** – Helps to evaluate the thickness of insulation on steam lines.
- **ASDMaster** – Helps users determine the economic feasibility of an ASD application.
- **PHAST*** – Helps users assess how much energy is used and model ways to improve performance.

*Coming Soon!

Tools and Training Impacts

Average Annual Savings Identified
(in Thousands of Dollars)

	Forest Products	Refining	Mining	Steel	Aluminum	Chemicals
Pumps	186.5	46.0	410.7	231.5	74.4	
Compressed Air	128.9	118.6	235.6		107.0	127.0
Process Heating		1,112.5	1, 231.9	1, 500.0	945.0	
Steam	365.9	365.9	102.5	1,010.0		1,565.0

Systems Management: MotorMaster+ Main Menu

MotorMaster+ Purpose and Scope

- Supports improved management and efficient operation of motor systems
  - Productivity gains
  - Reduced downtime
- Evaluates cost of purchasing and operating new motors
  - Dollar and utility savings
- Provides ability to evaluate conservation opportunities and log maintenance actions
  - System reliability improvements

MotorMaster+ Features

- Motor price and performance database
- Motor selection tool
- Inventory management
- Maintenance logs
- Utility module, including motor rebate program support
- Life cycle cost analysis
- Tracks energy, cost savings, and other benefits

MotorMaster+ Motor Comparisons

- New, energy-efficient motor *vs*.
  new standard motor
- Repair *vs.*
  new energy-efficient motor
- Replacement with new, energy-efficient motor *vs.*
  continued operation of standard motor

Systems Management:

Pumping System Assessment Tool (PSAT)

PSAT: Purpose and Scope

- Help end users identify systems worthy of further consideration (extension of prescreening process)
- Generate “what if" assessments, following the system head-capacity curve
- System loss shedding opportunity assessment
- Limitations:
  - Only 2 through 8 pole motors included in database
  - Several common pump styles are not included, for example:
    - "Plain" vertical turbine
    - Submersible
  - No explicit provision for adjustable speed drives

PSAT: General Methodology

- Uses measured fluid, electrical data.
- Extracts average motor performance characteristics from the MotorMaster+ database.
- Employs Hydraulic Institute algorithms for achievable pump efficiency.
- Estimates existing, "optimal" pump and motor efficiencies and associated operating costs.

PSAT Results: Alcoa NA Extrusions

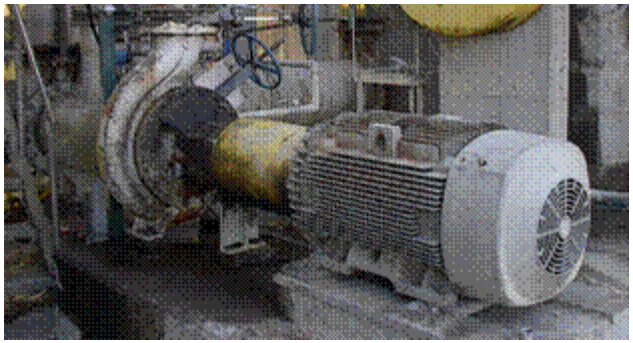
Pumping System Assessment

Cressona Extrusion Plant

- Estimated annual savings range from $26,000 to $55,000
- Assessment cost: $10,000

Opportunities Identified

- Trimming of pump impellers
- Installation of adjustable speed drives
- Checking lift settings
- Determining if a single pump will suffice where two are currently used



- Oak Ridge National Laboratory
- ALCOA North American Extrusions

Systems Management:

Steam System Scoping Tool

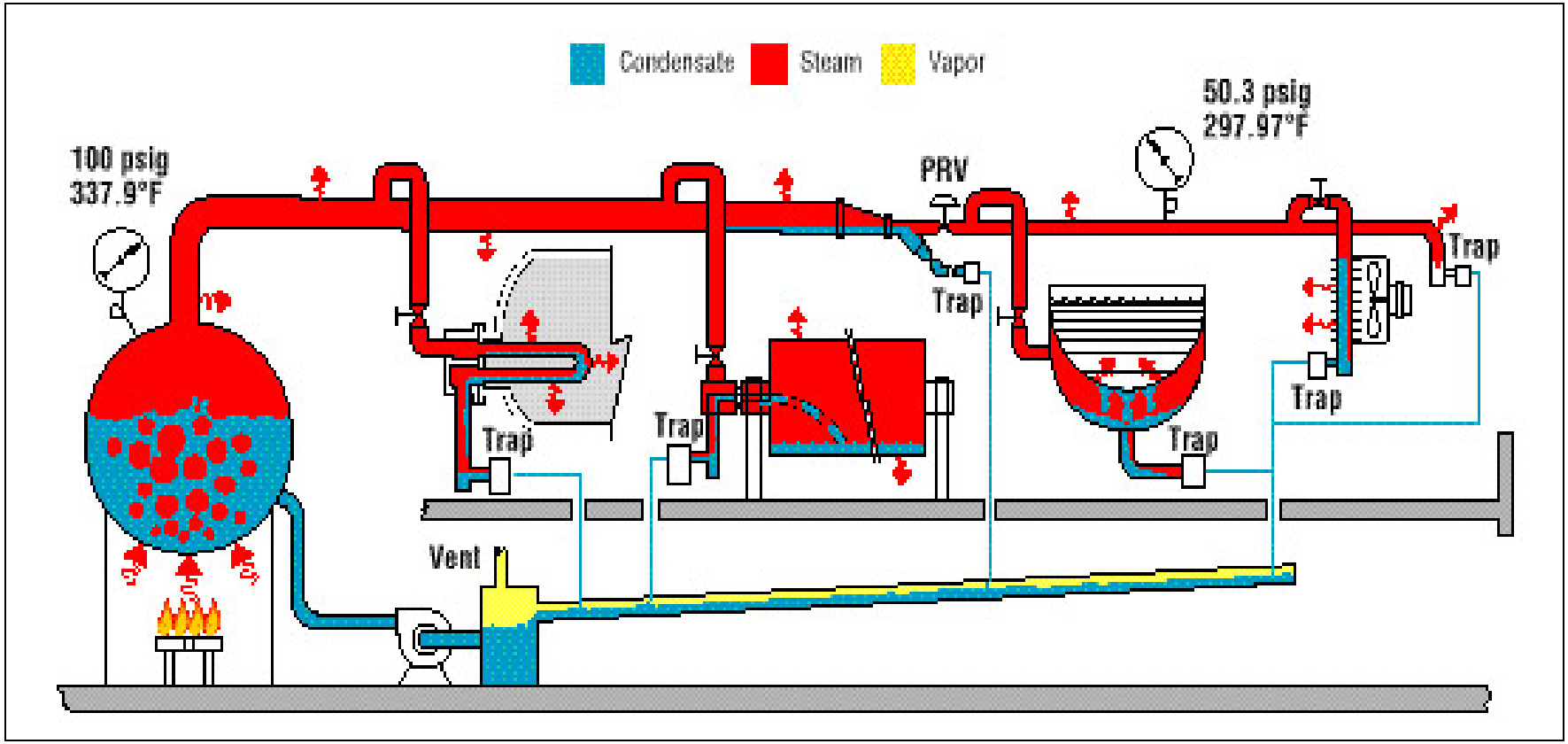
Steam System Scoping Tool: Purpose and Scope

The Steam System Scoping Tool was developed to help industrial users do the following:

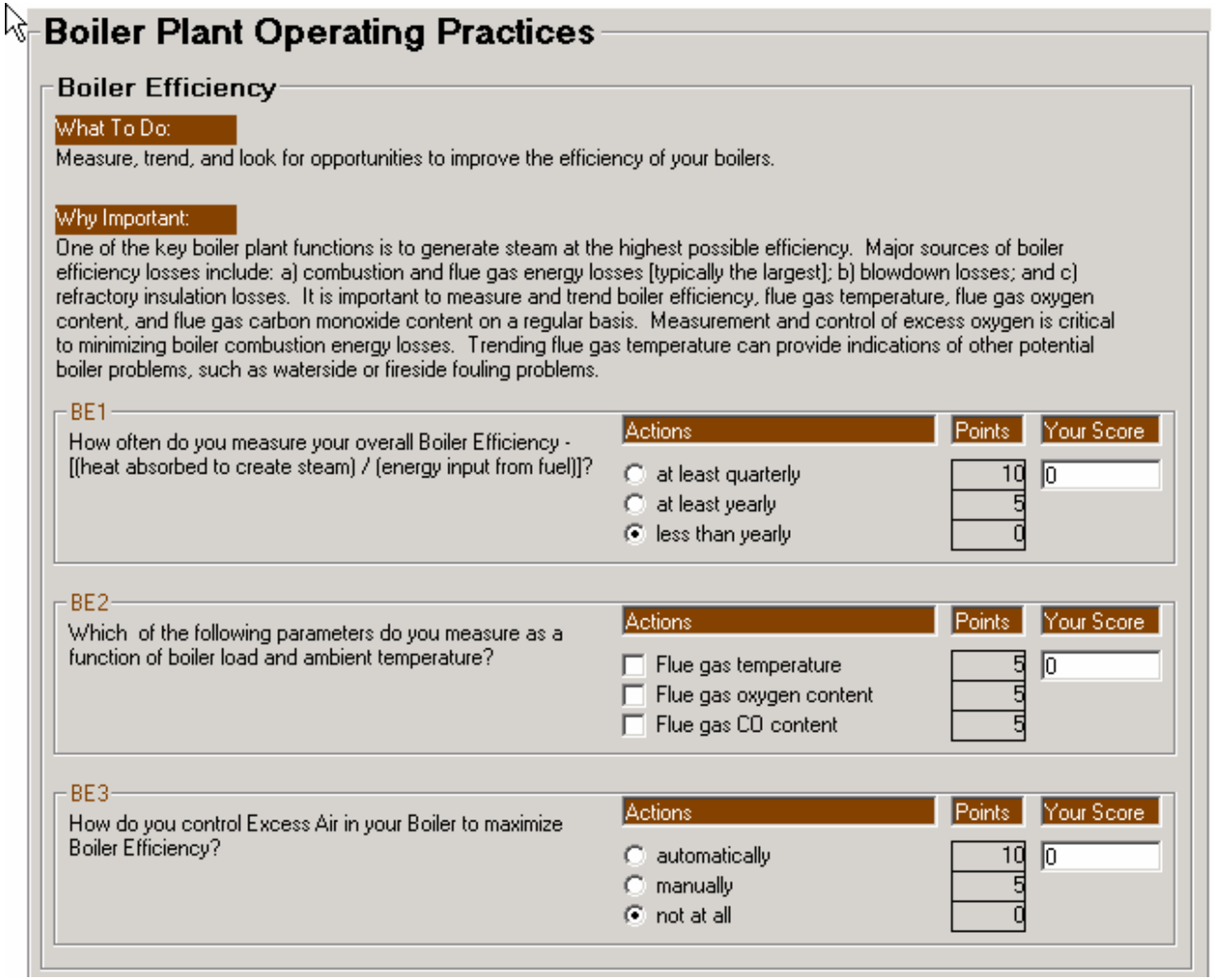
- Evaluate their steam operations against identified best practices
- Develop greater awareness of energy efficiency, productivity improvements
- Compare tool results with those obtained by other users

Steam systems have four basic components.

Generation, Distribution, End Use, Recovery



Typical Input Page



Boiler Plant Operating Practices

Boiler Efficiency

What To Do:

Measure, trend, and look for opportunities to improve the efficiency of your boilers.

Why Important:

One of the key boiler plant functions is to generate steam at the highest possible efficiency. Major sources of boiler efficiency losses include: a) combustion and flue gas energy losses (typically the largest); b) blowdown losses; and c) refractory insulation losses. It is important to measure and trend boiler efficiency, flue gas temperature, flue gas oxygen content, and flue gas carbon monoxide content on a regular basis. Measurement and control of excess oxygen is critical to minimizing boiler combustion energy losses. Trending flue gas temperature can provide indications of other potential boiler problems, such as waterside or fireside fouling problems.

BE1

How often do you measure your overall Boiler Efficiency - [(heat absorbed to create steam) / (energy input from fuel)]?

Actions	Points	Your Score
○ at least quarterly	10	0
○ at least yearly	5	
◉ less than yearly	0	

BE2

Which of the following parameters do you measure as a function of boiler load and ambient temperature?

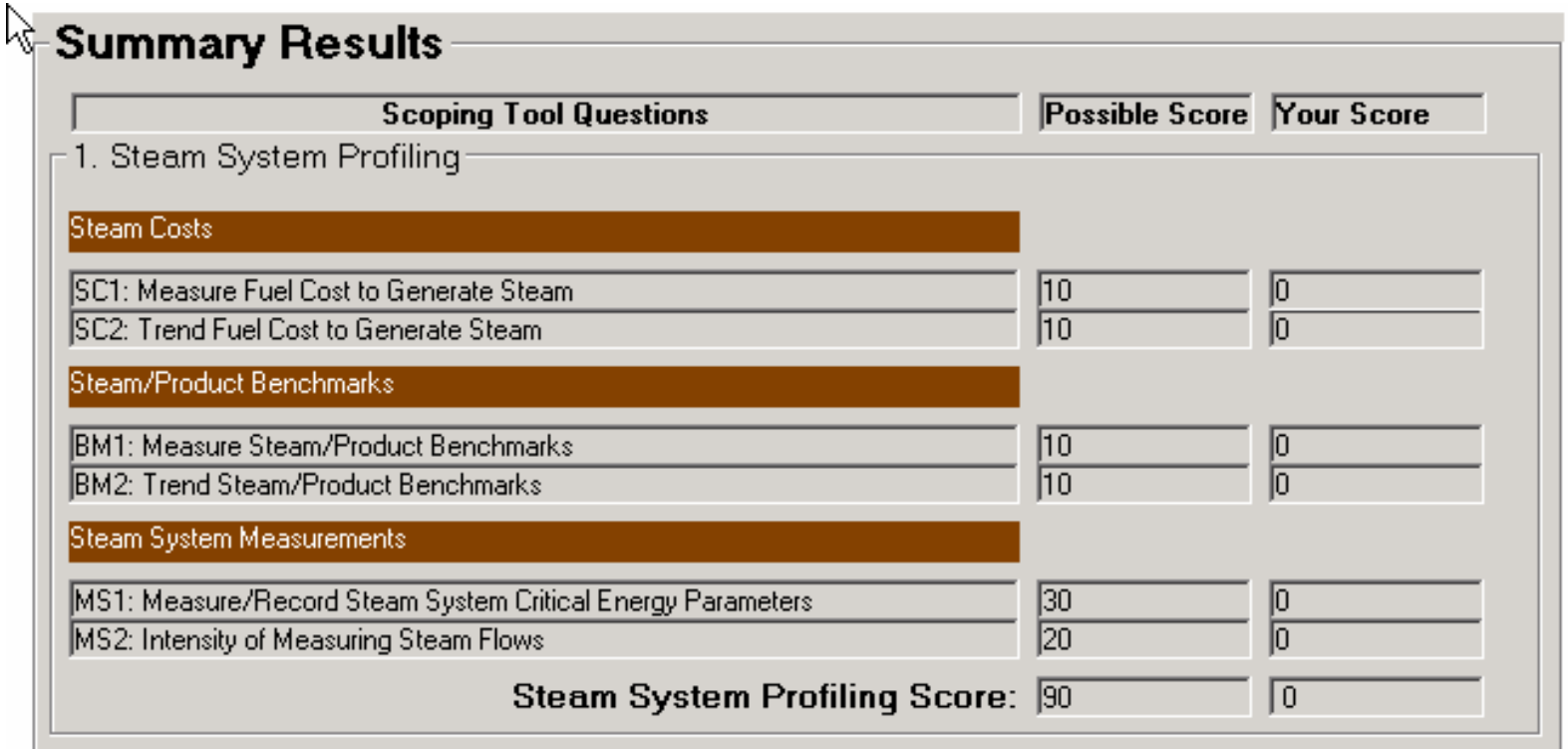
Actions	Points	Your Score
☐ Flue gas temperature	5	0
☐ Flue gas oxygen content	5	
☐ Flue gas CO content	5	

BE3

How do you control Excess Air in your Boiler to maximize Boiler Efficiency?

Actions	Points	Your Score
○ automatically	10	0
○ manually	5	
◉ not at all	0	

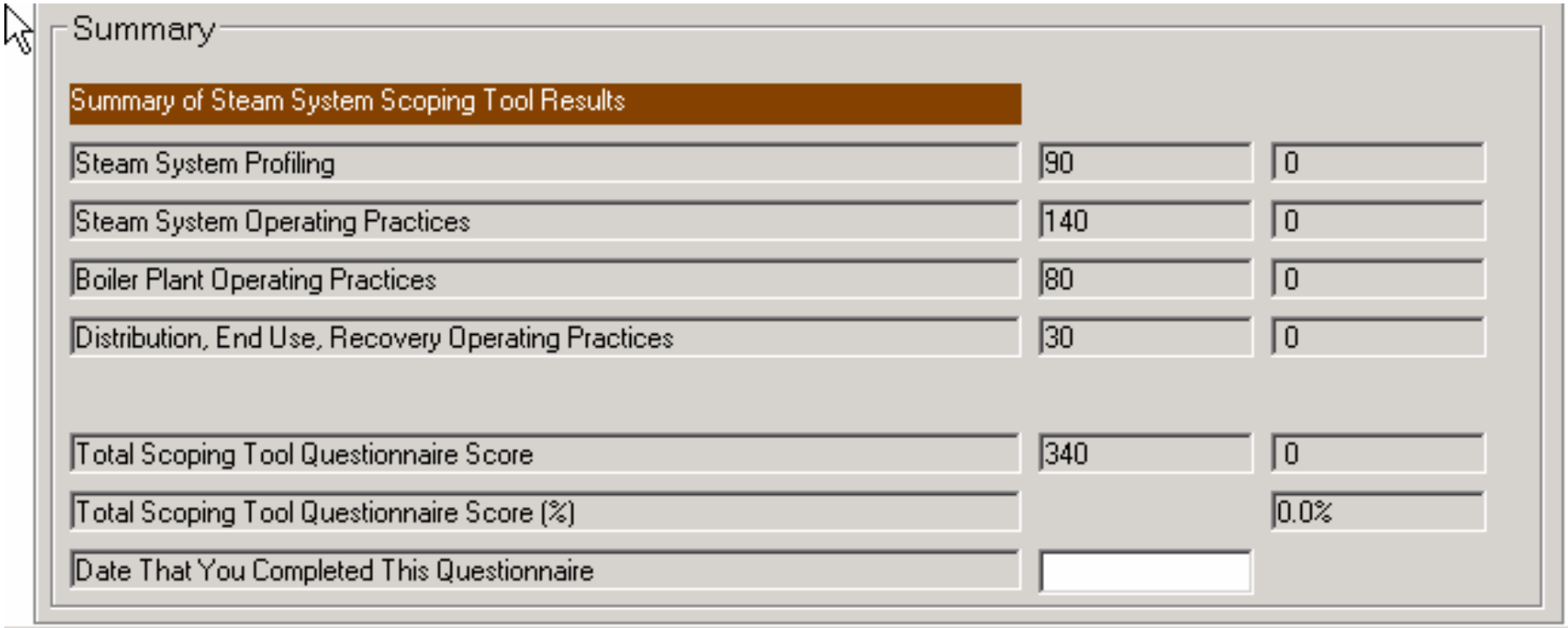
Typical Summary Page



Summary Results

Scoping Tool Questions	Possible Score	Your Score
1. Steam System Profiling		
Steam Costs		
SC1: Measure Fuel Cost to Generate Steam	10	0
SC2: Trend Fuel Cost to Generate Steam	10	0
Steam/Product Benchmarks		
BM1: Measure Steam/Product Benchmarks	10	0
BM2: Trend Steam/Product Benchmarks	10	0
Steam System Measurements		
MS1: Measure/Record Steam System Critical Energy Parameters	30	0
MS2: Intensity of Measuring Steam Flows	20	0
Steam System Profiling Score:	90	0

Summary of Results



Summary

Summary of Steam System Scoping Tool Results		
Steam System Profiling	90	0
Steam System Operating Practices	140	0
Boiler Plant Operating Practices	80	0
Distribution, End Use, Recovery Operating Practices	30	0
Total Scoping Tool Questionnaire Score	340	0
Total Scoping Tool Questionnaire Score (%)		0.0%
Date That You Completed This Questionnaire		

Steam System Scoping Tool: Results/Trends

Category	Possible Score	Average Score	Stand. Dev.
Profiling	90	43	30
System OP	140	112	14
Boiler OP	80	50	17
D/EU/R OP	30	16	5
TOTAL	100%	65%	16%

Steam System Assessment Tool (SSAT)

- PURPOSE:
  - Demonstrate magnitude – energy, cost, emission savings – of key steam system improvement opportunities

You Can Use SSAT To Evaluate These Key Steam Improvement Initiatives

- Real Cost Of Steam
- Steam Quality
- Boiler Efficiency
- Alternative Fuels
- Cogeneration Opportunities
- Steam Turbines vs PRVs
- Boiler Blowdown
- Condensate Recovery
- Steam Trap Operating Efficiency
- Heat Recovery
- Vent Steam
- Steam Leaks
- Insulation Efficiency
- Emissions Calculations

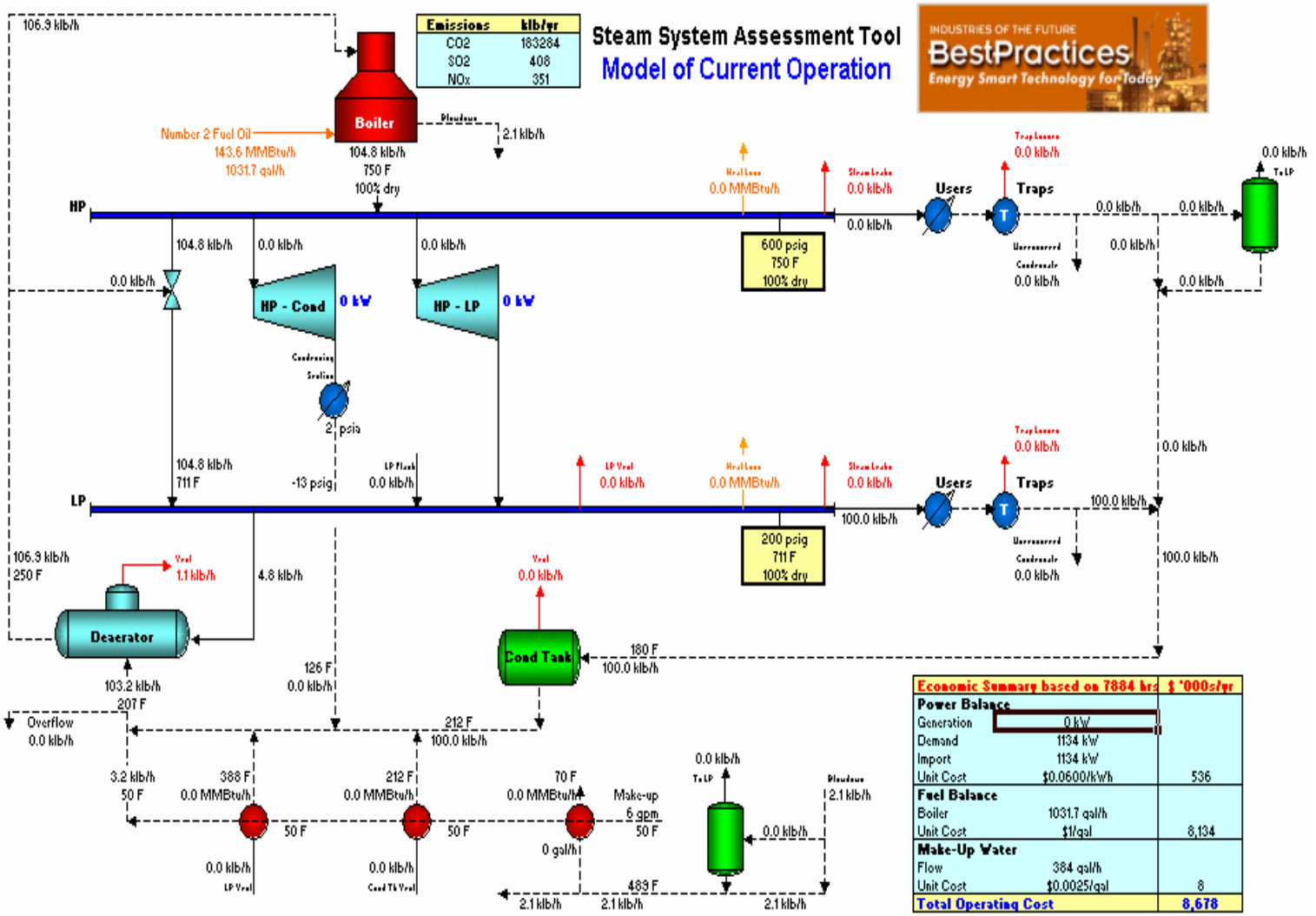
Key SSAT Features

- Choice of 1, 2, or 3 Header Pressure Models
- Schematics of Model Steam systems
- Estimates of Site Environmental Emissions

- Major Equipment Simulated:
  - Boiler
  - Back pressure turbines
  - Condensing turbine
  - Deaerator
  - Steam traps, leaks, insulation losses
  - Letdowns
  - Flash vessels
  - Feedwater preheat exchangers

SSAT

– Example Screen

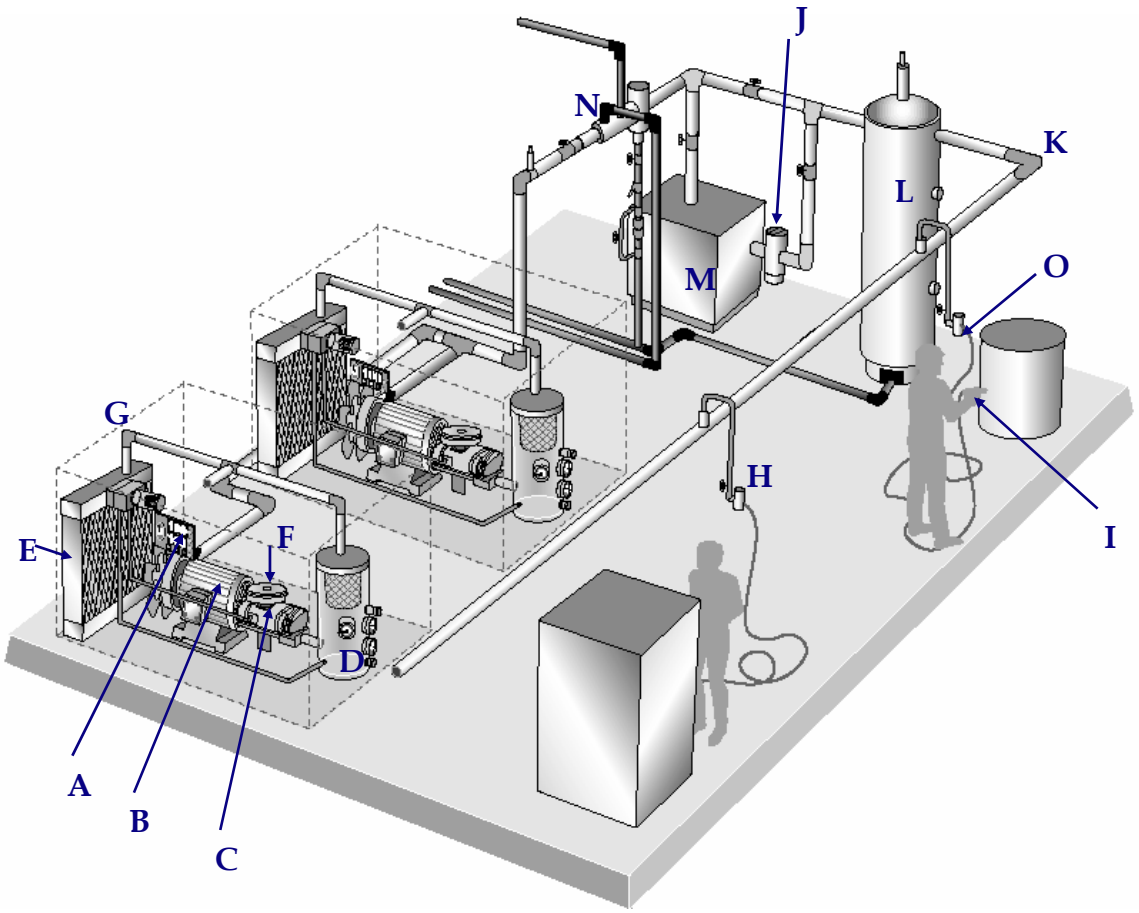


Systems Management:

AIRMaster+

Compressed Air Systems

AIRMaster+: Compressed Air System



A. Control Panel
B. Motors
C. Compressor Air End
D. Lubricant / Air Separator
E. Aftercooler and Lubricant Cooler
F. Air Inlet Filter
G. Compressor Package Enclosure
H. Filter, Regulator, and Lubricator
I. Pneumatic Tool
J. Air Filter
K. Distribution System
L. Air Receiver
M. Dryer
N. Supplemental Aftercooler
O. Leaks

AIRMaster+: Purpose and Scope

- Supports short-term, compressed air system assessments based on simple instrumentation
- Identifies low-risk and quick-payback operation and maintenance improvements
- Enables an efficient and systematic approach for objective and repeatable assessments
- Models supply-side airflow and electrical demands, but not dynamic effects of distribution and end use

Compressed Air System: Augusta Newsprint

Compressed Air System Assessment
Augusta, GA

- Estimated annual savings of $59,000 and over 1 million kWh
- Assessment cost: $5,000

Opportunities Identified

- Link the two compressed air systems and add a 10,000-gallon air storage tank to improve system efficiency.
- Identify and repair system leaks.
- Eliminate seldom-used equipment.
- Total cost of $75,000 with simple payback in 1.3 years

10,000-gallon air storage tank

Augusta Newsprint Company is part of a joint partnership between Abitibi Consolidated and the Woodbridge Company, Ltd.

Systems Management:

3E-Plus
Insulation Appraisal Software

3E-Plus: Purpose and Scope

Used for performing insulation appraisal calculations:

- Energy
- Environmental
- Economic

3EPLUS INSULATION TOOL

3E-Plus: Main Menu

NORTH AMERICAN INSULATION
MANUFACTURERS ASSOCIATION
(NAIMA)

Energy	Environment	Economics	Options
INSULATION THICKNESS Surface Temperatures Personnel Protection Condensation Control	CO2, NOx, CE Reduction w/ Insulation Thickness	ECONOMIC THICKNESS Calculations for a NEW Insulation Project	Thermal Conductivity ("k-Factor") MENU
ENERGY LOSS/GAIN Bare & Insulated Surfaces	CO2, NOx, CE Reductions for Economic Thickness Calculations	ECONOMIC THICKNESS Calculations from a PREVIOUS Project	External Covering (Jacket) MENU
$$ COST OF ENERGY Bare & Insulated Surfaces			Quit Program

Click any button to proceed

Use the F1 key on your keyboard for help on any form

3E-Plus: Energy Loss/Gain

- Inputs
  - Pipe size, material
  - Insulation material
  - Jacket material
  - Surface geometry
  - Operating hours
  - Process, ambient temperatures
  - Max. surface temp.
  - Wind speed
- Outputs (vs. insulation thickness):
  - Surface temp. (F)
  - Heat loss (Btu/ft-yr)
  - Efficiency (%)

3E-Plus Results: Georgia-Pacific

3E+ Insulation Evaluation

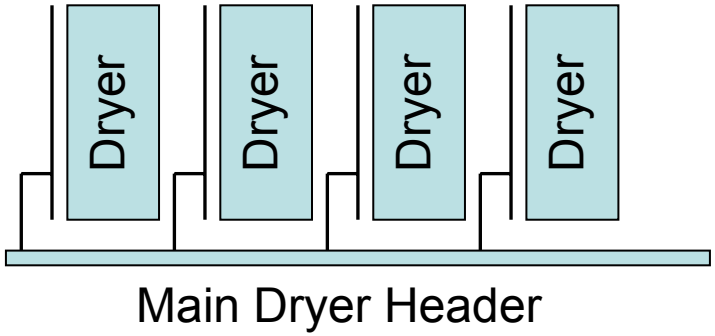
Georgia-Pacific plywood mill in Madison, GA

Saves $138,560 in annual energy costs and reduces CO_2 emissions

Opportunity Identified

Install 2-inch mineral pipe insulation on 970 feet of steam lines.

The insulation increased dryer temperatures, reduced processing time, and cut a boiler energy consumption by 63 billion Btu annually.

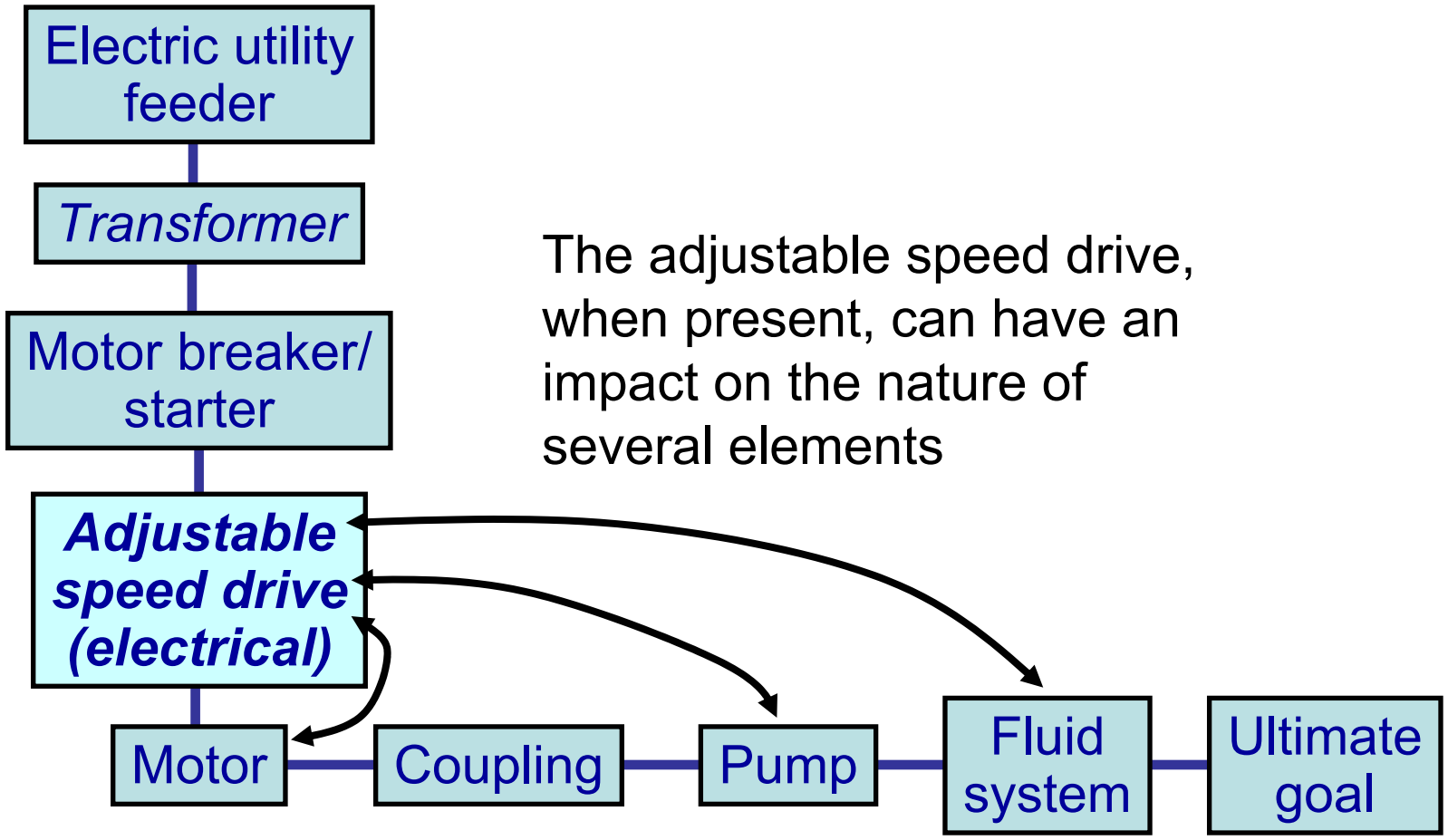


- Georgia-Pacific Corp.
- NAIMA
- Rock Wool Mfg., Inc.

Systems Management:

Adjustable Speed Drive (ASDMaster)

Adjustable Speed Drives

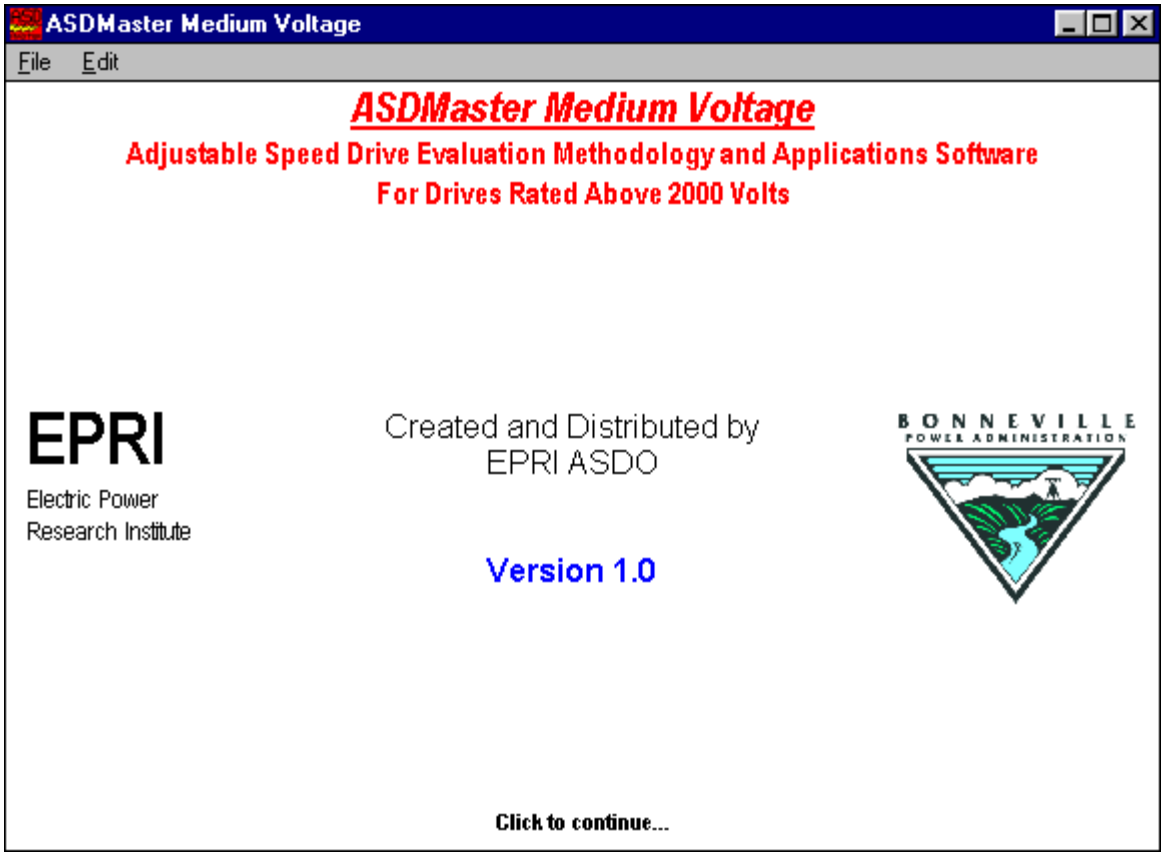


The adjustable speed drive, when present, can have an impact on the nature of several elements

ASD MASTER

ASDMaster

Provides the end-user with a tool to help with the application of ASDs to control process systems



ASDMaster: Program Goals

- Educate users on ASD technology
- Educate users on analyzing ASDs as part of an overall system.
- Assist users in properly analyzing the energy use of ASDs.
- Assist users in properly specifying and implementing ASDs.

ASD MASTER

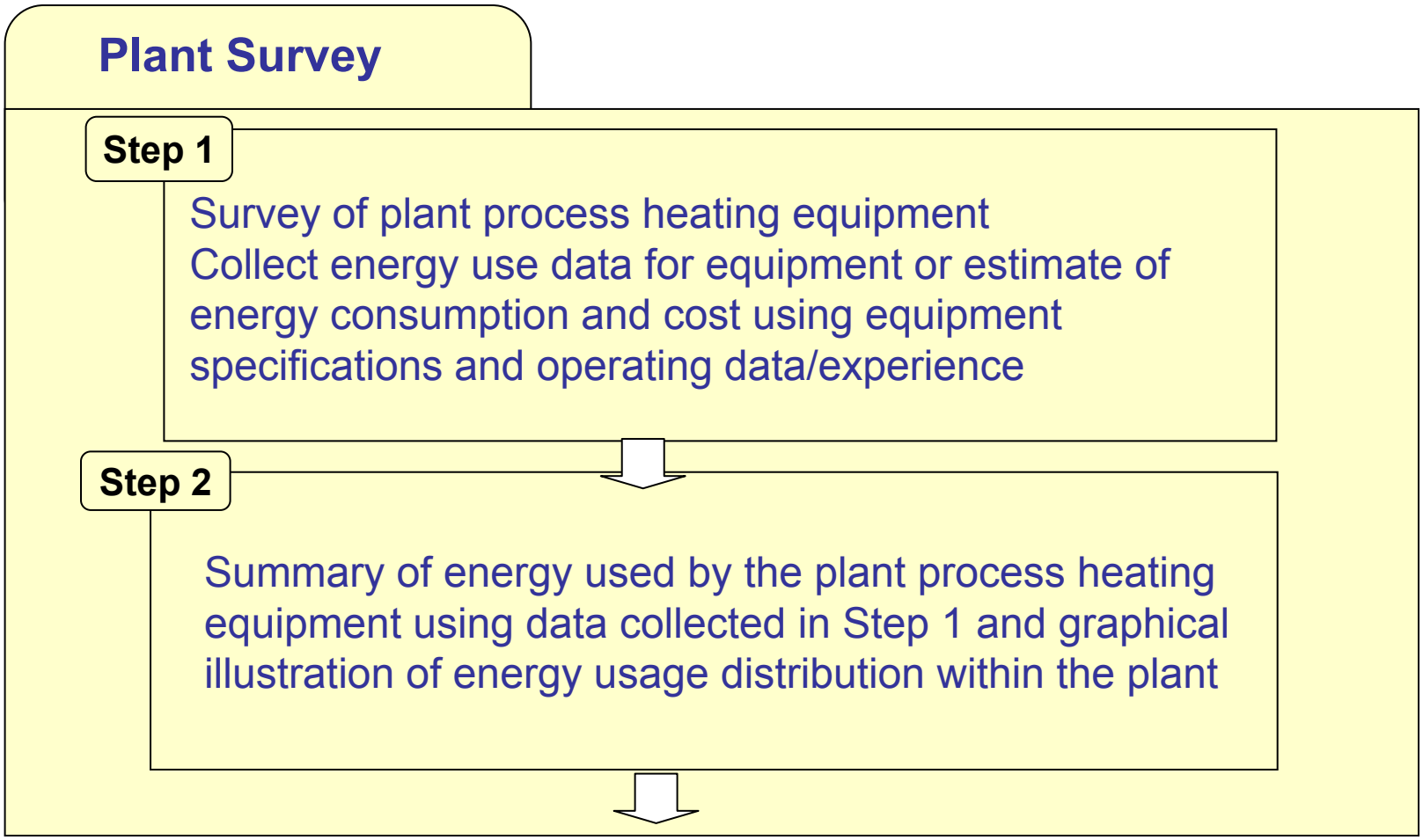
ASDMaster can help you to…

- Perform energy analysis of potential ASD applications.
- Compile an ASD specification and bid list.
- Determine the economic value of an ASD's non-energy benefits.
- Analyze an the economics of an ASD application

Systems Management:

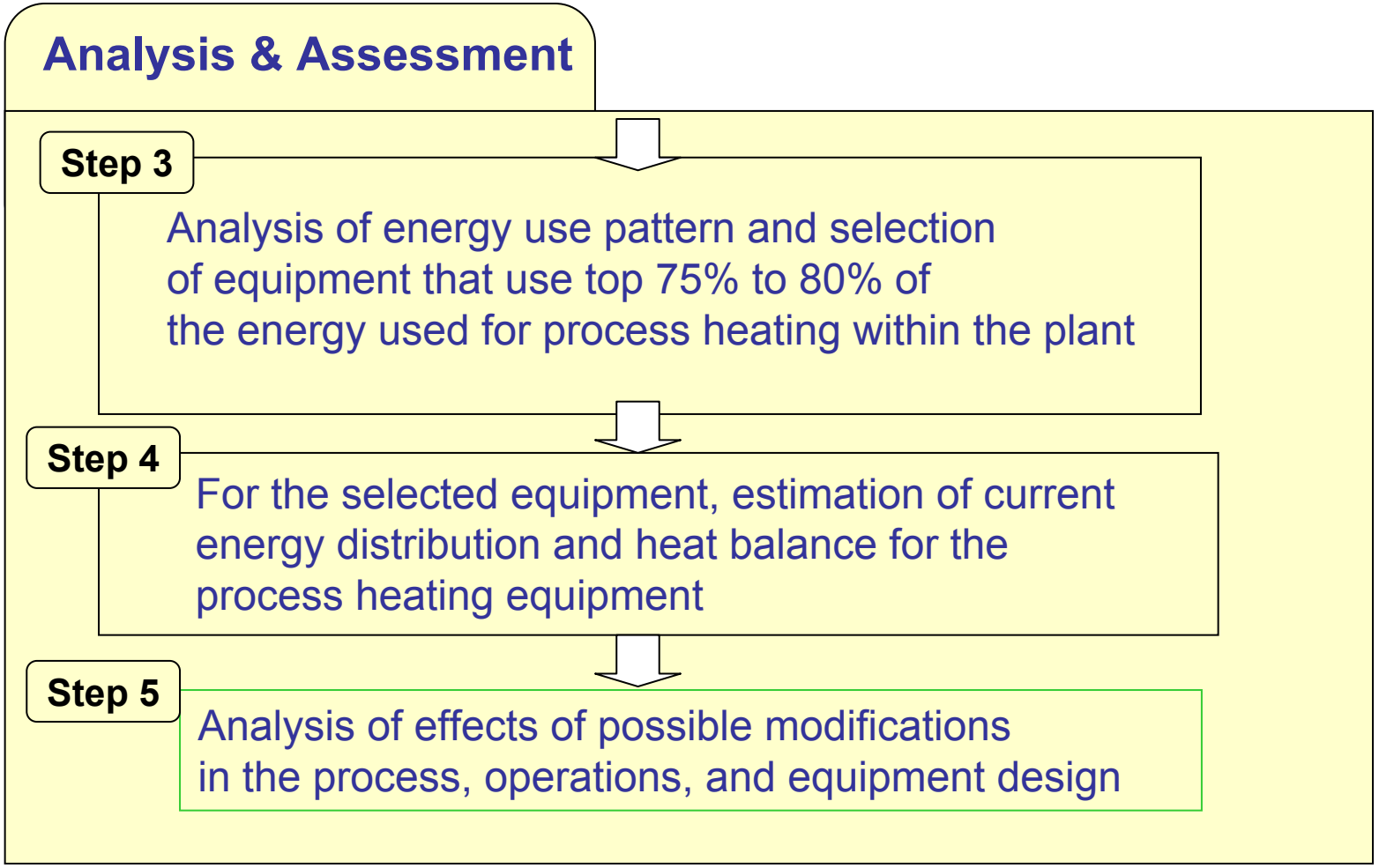
Process Heating Assessment and Survey Tool (PHAST)

PHAST: Plant Survey



(cont'd)

PHAST: Analysis & Assessment



PHAST: End Result

Supporting Tools / Guide End Result

Support

Guidance on method of data collection and instrumentation requirements

Check list for energy saving methods for process heating equipment

A tool to analyze effect of combustion variables on the “available heat” for the process

End result

List of possible activities and Resource Guide for further actions

PHAST Results: Alcoa NA Extrusions

Process Heating Assessment
Plant City Extrusion Plant

- Estimated annual saving of $450,000

Opportunities Identified

- Maintain minimum required free oxygen in combustion
- Eliminate formation of excess carbon monoxide
- Preheat combustion air
- Use of water/air nozzles for accelerated cooling
- Optimize insulation
- Use of high convection or radiation burners
- Operate with full load minimum idle time

- CSGI, Inc.
- ALCOA North American Extrusions

NOx TOOL

OBJECTIVE

Design a Tool that assists the development of a cost-effective, plant-wide strategy and plan for NOX reduction and energy efficiency improvements.

The scoping tool is meant to be a general guide to assess available options for energy efficiency improvement and NOx reduction.

NOx TOOL

- It will include:
  - information on commonly used methods of energy efficiency improvement and NOx reduction using the available technologies, hardware or systems.
  - Information on resources that will enable user to estimate energy reduction for equipment and processes used in chemical – petroleum refining plants.
  - Information on NOx reduction through use of currently available combustion systems and other NOx reduction technologies.
  - Data on cost of NOx reduction technologies/equipment and "rule-of-thumbs" for implementation cost obtained from the vendors and E&C firms.
  - A model for consolidating and summarizing result and summary of the end-effects.

NOx TOOL

- All data will be presented as "default" data that can be changed by the user to allow for specific situations.

- This is only a scoping tool and not a substitute for detail engineering study that may be required to meet regulatory requirements.

Tool Approach

Step 1 - Divide plant into three major sections

Step 2 – Define plant supply side

Step 3 – Define plant demand side

Step 4 – Define plant distribution network

Step 5 – Define conceptual cost-effective combustion system improvement opportunities in Section 1

Step 6 – Define conceptual cost-effective energy efficiency improvement opportunities in Section 2

Step 7 –summarize NOx reduction, energy savings and cost resulting from steps 5 and 6 & Identify the "gaps" between what can be achieved vs. the regulatory requirements

Step 8 – Define conceptual cost-effective 'tail-pipe" NOx reduction opportunities for selected Sources

Step 9 – Summarize and save the results steps 6, 7, and 8

Step 10 – Review and select select the most cost effective or applicable option for further considerations

NOx TOOL

Summary Report

Example of the Reported Items for Each Option Considered
(to be revised based on recommendations from the industry advisory committee)

- **Total NOx reduction: ** Tons/year**
- **Total Energy Savings *** MM Btu/year**
- **Capital Cost : **** $ per annual ton of NOx reduction**
- **Payback periods (NPV or IRR)**
- **Risk factor**

NOx TOOL

Report Links

- Links to DOE-OIT Best Practices Tools (Process Heating, Pump System, Compressed Air, Steam System)
- Information and guide to Low NOx burner performance and cost data collected from the vendors and engineering companies
- Information on typical cost-performance data for "tail-pipe" NOx reduction systems

Report References

- List of suppliers and consultants
- Case studies supplied by the industry advisors
- Reference to articles and literature sources related to NOx reduction and energy efficiency improvements

EERE Industrial Energy Efficiency Training Opportunities

- Motor Systems Management
- Steam Systems Improvement
- Pump System Assessment
- Pump System Assessment Tool (PSAT) *Specialist Training*
- Fundamentals of Compressed Air Systems
- Advanced Management of Compressed Air Systems
- AirMaster+ *Specialist Training*
- Insulation Assessment
- Optimization of Process Heating Systems
- Process Heating Assessment Tool (PHAST) *Specialist Training*

Schedule Training

Contact your state energy office or Regional DOE Office:

Atlanta
David Godfrey
404-562-0568

Boston
Scott Hutchins
617-565-9765

Chicago
Brian Olsen
312-886-8579

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